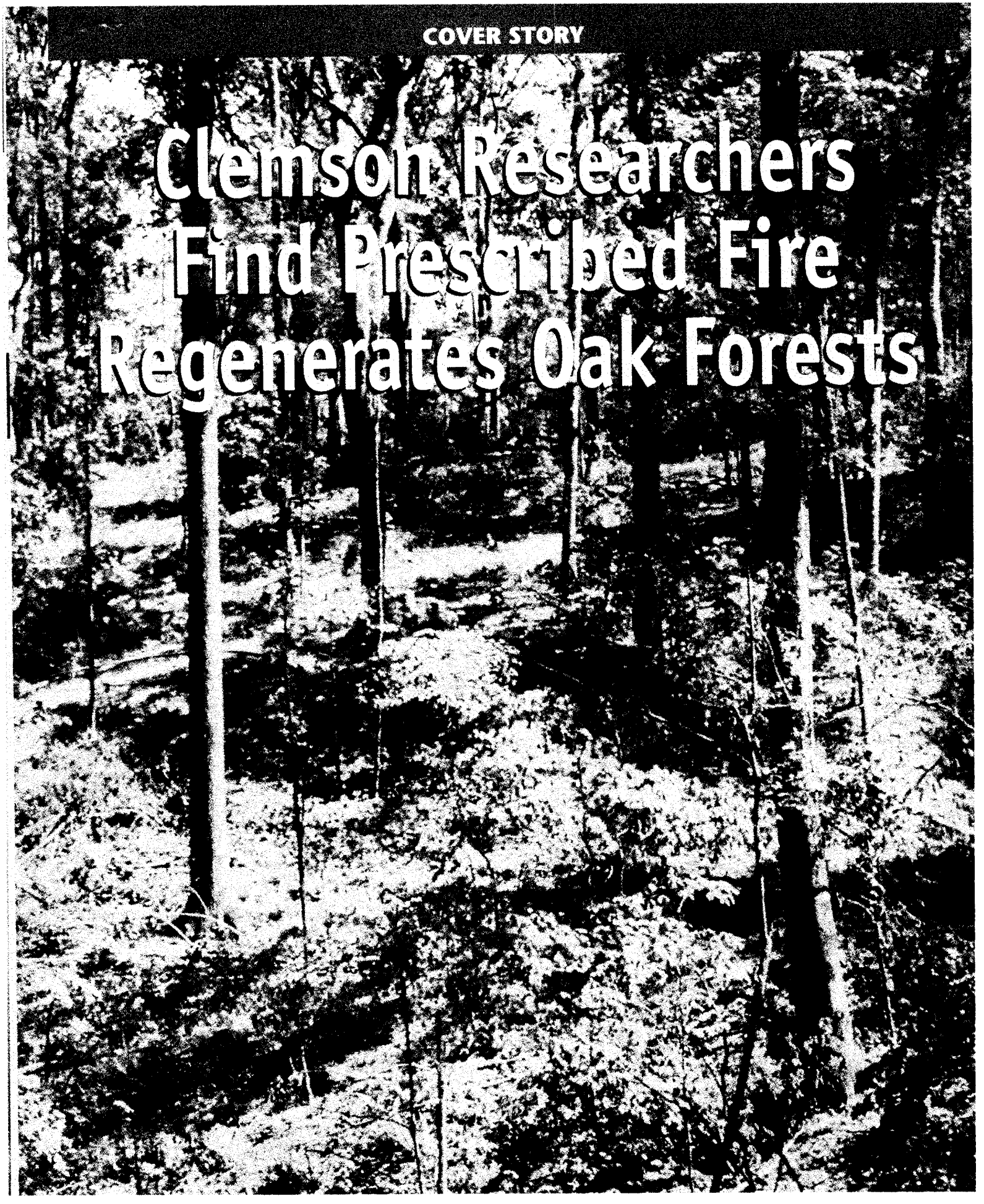
Clemson Researchers Find Prescribed Fire Regenerates Oak Forests



Fire is being prescribed by Clemson University forestry researchers to regenerate oak forests. Regenerating oaks following timber harvests is a major challenge because faster growing yellow poplar and red maple trees crowd out the more valuable oak seedlings.

"The prescribed burn reduced the number of yellow poplar and red maple seedlings and saplings dramatically, with minimal impact on the oak regeneration," said Clemson forestry professor David Van Lear, who conducted the research with associate Patrick Brose. "We also found that hickory regeneration was not diminished by the burn.

"Following partial removal of the over-story canopy, oaks and hickories put their early growth into the root system while poplars and maples grow stems," Van Lear said. "A few years after a partial harvest, a prescribed fire is run through the regeneration. The oaks and hickories have the reserves to send up new sprouts, but the other species don't."

Before the burn, the researchers harvested about half the hardwood stand, leaving the largest and best trees to generate new seedlings. Then they waited for the regeneration process to develop. Yellow poplar was the most prolific, with 4,000 seedlings per acre, compared to slightly more than 1,000 red maple and oak and about 750 hickory seedlings.

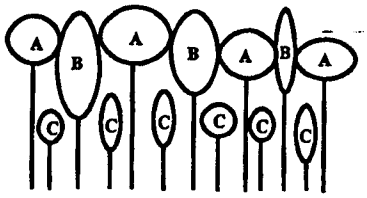
"Regenerating oak stands on productive upland sites in the Piedmont region is a major problem because of intense competition from yellow poplar," according to Van Lear. "As a potential solution to this problem, we tested the hypothesis that a shelterwood harvest of an oak-dominated stand, followed several years later by a prescribed fire, would adequately regenerate the stand."

In the study, three oak-dominated stands, in which shelterwood harvest had been conducted several years earlier, were each divided into winter burn, spring burn, summer burn, and control treatments. Prescribed fires top-killed nearly all hardwood regeneration, forcing the rootstocks to resprout.

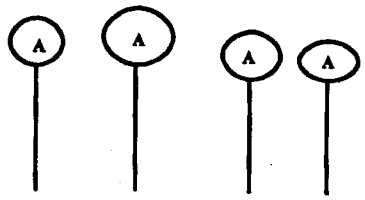
Three years after the prescribed fires, oak had the higher density and stocking in burned as compared to unburned areas, while yellow poplar had its highest density and stocking in the control areas. Relatively high intensity spring burns gave the best results, providing the oaks

"Areas treated with high-intensity fire during the spring will develop into oak-dominated stands after just one burn. Control areas and areas treated with low-intensity fire will become dominated by yellow poplar. Other combinations of fire intensity and season of burn will produce mixed hardwood stands with varying proportions of oak."

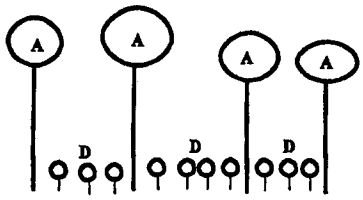
— David Van Lear



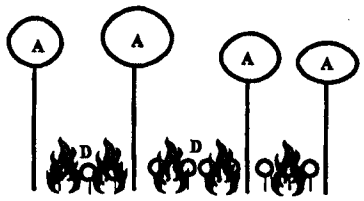
1. Typical upland mixed-hardwood stand.



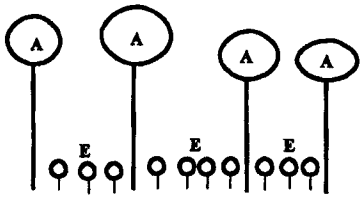
2. Initial cut to a shelterwood (40 to 60% basal area reduction).



3. After 3-5 years, yellow-poplar dominates the advance regeneration pool.

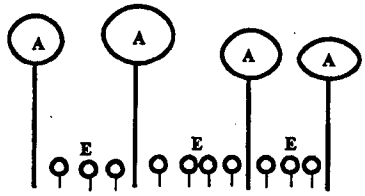


4. Prescribed fire topkills the advance regeneration, forcing rootstocks to sprout. Overstory damage and mortality limited to trees with slash at their bases.

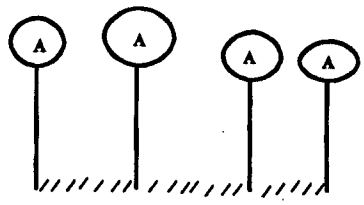


5. Oak now dominates the advance regeneration pool. Three management options available.

6a. Overstory harvested and additional fires withheld creates a new oak forest.



6b. Overstory retained and additional fires withheld creates a two-age stand.



6c. Repeat burning either stockpiles oak sprouts or creates an oak savanna.

Figure 1. Schematic diagram of the shelterwood-burn technique. A = high quality oaks; B = hickories, poor quality oaks, and yellow-poplars; C = American beech, flowering dogwood, and red maple; D = mixed hardwood regeneration dominated by yellow poplar; and E = mixed hardwood regeneration dominated by oaks.

Photo: David Van Lear

and hickories with an advantage over their competitors.

"Areas treated with high-intensity fire during the spring will develop into oak-dominated stands after just one burn," said Van Lear. "Control areas and areas treated with low-intensity fire will become dominated by yellow poplar. Other combinations of fire intensity and season of burn will produce mixed hardwood stands with varying proportions of oak."

All prescribed fires also improved oak stem form and stimulated height growth of hickory and oak.

The shelterwood-burn technique developed by Van Lear and Patrick Brose includes a number of factors:

DETERMINE APPLICABLE SITES AND CONDITIONS — Currently recommended for medium-quality upland sites in the Piedmont region where yellow poplar, sweetgum, and red maple are serious competitors of oak. The technique is untested in other regions and on other sites but may work with modification to account for different environmental factors. Two required pre-existing conditions are that oak regeneration is is present (at least 750 stems per acre) but suppressed (about 1 foot tall) and that prescribed burning is possible.

Apply the Technique

1. THE INITIAL SHELTERWOOD HARVEST

- Plan prescribed burn and timber sale at the same time, i.e., skid trails become fire control lines.
- Mark 15 to 30 dominant oaks per acre as "leave" trees. Ideal leave tree has a straight, clean bole with no signs of epicormic branching, is 15 to 16 inches diameter breast height, and has a full healthy crown. Make sure you do not mark yellow poplars as leave trees.
- Cut all unmarked stems and leave slash in the stand. Such a harvest provides fuel for the prescribed fire and recycles nutrients into the forest soil. If sweetgum is anticipated to be a serious competitor, harvest during the summer to reduce vigor of root sprouts. Otherwise, harvesting can occur any time during the year. If existing oak regeneration is absent or scarce (less than 500 stems per acre) and no acorn crop is anticipated, delay the initial cut until a plentiful acorn crop is foreseen.
- Use directional felling to prevent logging slash from accumulating at the bases of residual trees. Remove any such slash.
- If stand is an existing shelterwood, removal of logging slash from tree bases may be warranted. Otherwise, mortality of residual overstory trees will likely be four to five per acre.

2. THE THREE- TO FIVE-YEAR WAIT

- This time period permits regenerating oaks to develop their root systems, giving them resistance to fire.
- It allows seeds and roots of competing species to germinate and sprout, making their reproduction extremely vulnerable to fire.
- It creates a continuous fire fuel bed as litterfall from residual overstory trees blankets the forest floor.
- It lets residual overstory trees recover from the shock inherent in any stand disturbance.

3. THE PRESCRIBED FIRE

- Growing-season fires (spring and summer) are superior to dormant-season fires (fall and winter) for killing regeneration of red maple, sweetgum, and yellow poplar.
- Firing pattern should emphasize slow-moving fires (1 to 5 feet per minute) that produce high amounts of heat (2- to 4-foot flame lengths).
- Additional prescribed fires may be needed in the future depending on management objectives, degree of competition by less-desirable species, and season/intensity of prescribed burning.

Potential Applications

- **TIMBER MANAGEMENT** — Oak stands can be perpetuated on productive upland sites for high-quality saw logs.
- **WILDLIFE MANAGEMENT** — The technique is ideally suited for upland species such as deer, turkey, and squirrel.
- **ECOSYSTEM RESTORATION** — Cutting and burning regimes can be varied to create open oak woodlands and savannahs.

Foresters have used prescribed fire as a management tool in pine stands for decades. Until now, prescribed fire in hardwood stands was considered inappropriate. However, the Clemson study suggests it could be a valuable tool in hardwood management.

Following a partial harvesting with prescribed fire could enable landowners to regenerate oaks and hickories and maintain the value of their timberland. Further research will be conducted to determine whether a single burn is sufficient to allow the hardwoods to grow into a canopy, or dominant, position in the forest.

The prescribed burn research was conducted in cooperation with the Virginia Division of Game and Inland Fisheries. Van Lear and Brose's research is sponsored by the South Carolina Agriculture and Forestry Research System based at Clemson University.